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two articles in the *Geographical Magazine* for October, by Mr. Ravenstein, accompanied by four maps exhibiting the spread of Mohammedanism, the political divisions, the comparative density of population, and the nationalities; and the History of the Mongols from the Ninth to the Nineteenth Century, by Henry H. Howorth. — O. T. MASON.

GEOLOGY AND PALÆONTOLOGY.

THE GEOLOGICAL SURVEY IN CHARGE OF PROF. F. V. HAYDEN. — The productiveness of the work pursued in America by Professor Hayden, the greatness of the results obtained by this savant and the collaborators whom he has associated with him, the hope and expectation of having science enriched by new discoveries of which those of these last times seem but a prelude,—all these considerations have deeply impressed the French savants, who attentively watch the researches of every kind in geography, physics, botany, zoology, and especially geology and palæontology, pursued through the unexplored Territories of the United States west of the Mississippi, and towards the Rocky Mountains. It would be impossible to trace out, even in a summary, what is the most striking and interesting part in the undertaking of Professor Hayden, and I must merely mention some essential points which from the speciality of my studies I am prepared to appreciate to their full value. It is certain, first, that the Yellowstone or Geyser region, recently surveyed and preserved by the wisdom of the Federal government against the danger of devastation, put to the disposition of science the exposition of an assemblage of phenomena of the highest interest. Their examination will serve to explain the mode of formation of the lacustrine deposits of Europe, where the geyserian action is so remarkably visible. Henceforth it will be easy to follow the proceedings formerly employed by nature on the European Continent, and which now are in full action in the central part of the American Union. It is also evident to the geologist who considers the general classification of the formations, as it is fixed from the order of the materials as they exist in Europe, that a great revolution is preparing in geology from the discoveries in regard to the stratigraphy of the Territories recently explored under the direction of Dr. Hayden. The Dakota group and the lignitic formation constitute, in fact, two systems of an enormous power, wherein the fresh-water formations of an uncommon thickness are directly superposed on the marine beds, or in alternation with them. Of these two systems the one is incontestably cretaceous, the other as incontestably tertiary, and both, equally rich in fossils, animal and vegetable, are so intimately bound together that the passage from the one to the other is by a series of degrees without interruption or gap.

Now this is indeed a fact of immense importance in this, that it disproves all that was supposed to have been observed positively in Europe in generalizing local and partial phenomena. In the minds of

the most eminent geologists of this side of the Atlantic the gaps which distinctly separate the cretaceous from the lower tertiary were admitted as corresponding to the end of a great period, and marking its separation from the following one, abruptly beginning a new order of things. Thanks to the American discoveries due to Dr. Hayden's perseverance we have now before us a formation composed of a union of strata of surprising extent, and these strata when they become carefully studied will teach us how the transition between the upper cretaceous and the most ancient tertiary has proceeded.

The radical separation, admitted until now, of the secondary times in regard to those which follow, is therefore uncertain in such a way that if geological researches, instead of beginning in Europe, had been first made in America, the classification would have been modified according to the facts recently obtained by Dr. Hayden; and we can even assert that it would have been founded upon at least different if not opposite bases. The natural consequence of the discovery of these new formations has been a rich harvest of animal and vegetable fossil remains, vertebrate and invertebrate. Here I will only speak about the plants which by their profusion and their variety form a complete herbarium, by which Mr. Lesquereux, as learned as modest, will be able to patiently reconstruct the vegetation of an epoch of which, a few years ago, even the existence was still unknown, at least contested. Nothing, indeed, was more obscure than the flora of the second half of the cretaceous until the Dakota group offered us their share of vegetable fossils. This obscurity was, and is still, a great obstacle to the study of those plants which show us the most ancient Dicotyledons, and take us back to an age when the vegetation of our globe was being completed by the addition and the rapid development of the highest and most numerous class which composes it at our time. Before this epoch, reduced as it was to a small number of relatively inferior types, the vegetation could evidently furnish to large land animals insufficient food. It is only from the appearance of the Dicotyledons just at the epoch when the strata of the Dakota group were deposited, that both kingdoms began their completion by the rapid and successive development of what they have most perfect in land animals and plants, before the arrival of man himself, this last complement of creation.

Not only have the plants of the Dakota group pre-ented to us types of which we could not formerly suppose the antiquity, but in the tertiary system which immediately follows the Dakota group, in the lignitic formation, the researches inaugurated by Dr. Hayden have already exposed to our knowledge the remains of a number of floras of various stations and of great richness. This vegetation, distinct from that of the Dakota group, is far more recent, but it has also its proper interest. Its relation with European contemporaneous floras has to be determined; its most interesting study will demand a great deal of patience and

hard work. It must be completed in time, by a long series of new researches, and nobody is better able to continue them on the same plan than Dr. Hayden, who has directed them until now with such thoughtful zeal and clearness of plan. The magnitude of the results already obtained warrants the hope of future discoveries. — COUNT G. DE SAPORTA, of Aix, France.

THE GEOLOGY OF ITHACA, NEW YORK, AND THE VICINITY. — The Cayuga Lake basin of Western New York extends in a general north and south direction, attaining a length of over forty miles. The land inclosing it on the north is comparatively low, and the lake is broad and shallow. Southward the land increases in elevation, the lake becomes deeper, and the head of the basin is inclosed by a high hilly region. Along the shores of the lake for its entire extent the various rocky strata from the Salina group to the Chemung are admirably exposed. Ithaca occupies the low alluvial plain at the head of the lake, about four hundred feet below the general level of the surrounding country. Many of the streams entering the valley at this point flow through deep gorges rendering the underlying Chemung rock easily accessible. From Fall Creek, which flows into the lake basin just north of the village, southward to the Pennsylvania line there is a continuous stretch of Chemung strata. Excepting for building-stone and flags, the economic value of this group is not great, as it is made up of shales and thin beds of sandstone. The characteristic fossils found at Ithaca are *Spirifera mesacostalis*, *S. mesastrialis*, and *Orthis impressa*. In addition to these there are a number of species of lamellibranchs, gasteropods, cephalopods, — some of which are quite large, — and brachiopods other than those mentioned. The best, and in fact the only, exposure of the Portage group, which underlies the Chemung, is immediately below the Ithaca Fall in the Fall Creek Gorge. This has afforded well-preserved fossils, some of which are quite rare. *Spirifera levis*, characteristic of the strata, occurs in great numbers, and so well preserved that the spires are frequently visible where the shell has been removed. But the exposures along the lake shore offer a richer field to the collector. By reference to a geological map of New York the various rocks of the Silurian and Devonian ages will be seen to stretch in long bands from east to west, that is, the beds all dip to the south and are imposed one upon the other in their regular order. As the Cayuga Lake basin cuts them transversely, it forms the basis of an excellent section of the western part of the State. The Hamilton formations are here well developed and are exposed along the lake shore for a distance of twenty-five or thirty miles. North of Ithaca the black, thinly laminated Genesee Shale is met, and, forming cliffs along the shore and precipitous walls to the small streams entering the lake, it continues exposed for two or three miles, thinning out and overlapping the Hamilton rocks proper. This shale affords very few fossils, though some well-preserved plant remains have been found. Separat-

ing the Genesee Shale from the Hamilton Shales a thick band of limestone — the Tully Limestone — rises from the water and after an undulating course of several miles passes off at the surface. Directly beneath this is the Moscow Shale, a dark, laminated mud-rock easily disintegrated by water, the Encrinal Limestone, — a very thin bed, — and the Ludlowville Shale. The Tully Limestone forms a rocky table upon which the streams often flow for a considerable distance, the dip of the bed frequently being so slight as to present nearly a level surface. As they approach the lake the water flows over the hard rocky table and cuts its way through the softer deposits. These are easily disintegrated by the combined action of frost and water, and are washed away, forming caverns below the limestone, which after a time breaks off, leaving large masses in the bed of the stream. This is particularly well exemplified in the glens about Ludlowville (eight miles north of Ithaca) and at Shurgur's Glen, near the lake shore. Both of these localities are much frequented by collectors. *Spirifera granulifera*, *S. medialis*, *S. mucronata*, and *Athyris spiriferoides* are found there in great abundance, also *Phacops bufo* and other trilobites, many species of lamellibranchs, and a number of cephalopods. This formation, known to geologists as the Hamilton Group, including the Tully Limestone, the Moscow Shale, the Encrinal Limestone, and the Ludlowville Shale, continues for many miles along the lake shore. From an economic stand-point the Tully Limestone only is important, being valuable for lime and building purposes. The only minerals found are calcite, in small quantities, and iron pyrites.

We turn now to the superficial deposits and water-courses. At Ithaca there are two distinct types of river or creek valleys — the one with rounded and well-worn sides, the other bordered by precipitous walls of rock. To the latter class belong Cascadilla and Fall creeks, which flow into the Ithaca plain from the east. Their valleys are true valleys of erosion, having been formed since the withdrawal of the vast ice-sheet which swept over this portion of North America in quaternary time. With the exception of Six Mile Creek Valley and that of Cayuga Inlet, which open into the lake basin from the southeast and south respectively, all the streams of this immediate vicinity flow through deep cuts or cañons, in which they descend by numerous cascades and water-falls to the lake. As their valleys are mere chasms, they make no appreciable change in the general contour of the land. With valleys of the first type, however, the effect is of an entirely different character. They are distinctly marked. Their longer slope and greater width make a prominent feature in the topography of Ithaca. Noting in addition the depth at which the water flows, and the small number of cascades and water-falls, the conclusion is at once reached that these valleys have been acted upon by some agency not now in operation. We can observe changes going on in Fall and Cascadilla creeks; we can easily understand how their deep, rocky cañons could be formed and are still being formed by

the action of water and frost upon shale, and we can readily see that the conditions which obtained in the formation of these valleys could never explain the deep, well-marked valleys of Six Mile Creek and the Cayuga Inlet, with their sloping banks and knolls and terraces. These deep, well-worn valleys are undoubtedly the result of glacial action. The mass of ice which filled the Cayuga Lake basin, dividing at its southern extremity, one part — the larger — flowed to the south, wearing down the Inlet valley, and the other traversed the Six Mile Creek valley, both of which were occupied by preglacial streams. The scratches on the polished surface of the underlying rocky table, as seen at the quarry in front of the buildings of the Cornell University, on the eastern edge of the basin, indicate that the glacier followed a direction a little east of south, corresponding with that of the lake. Among the drift accumulations are found boulders of Oriskany Sandstone, and masses of Hamilton shale, formations which occur to the north, together with small granitic boulders. The valley of Six Mile Creek furnishes some special examples of the drift phenomena. In several places its old channel has been completely choked up with masses of morainic débris about which the present stream has been obliged to cut its way through deep cañons. It was in this valley, at Mott's Corners, a few miles from Ithaca, that the remains of a mastodon were discovered several years since.¹

In the cañons of this creek and in the gorges of those streams of more recent origin trap dykes are not uncommon. In some cases they thin out before reaching the surface, as in the cañon of Six Mile Creek above Green Tree Falls. There is no apparent displacement of the strata, the dykes being merely cracks filled with igneous rock.

Intimately related to the geology of Ithaca is the problem concerning the origin of Cayuga Lake. At present this has not been satisfactorily solved. Theories have been advanced, but as yet none are sufficiently matured. A consideration of this subject will require a careful and detailed study of the entire lake system of Western New York. While Ithaca does not present that field of study in structural geology to be found in a mountainous or disturbed region, it does offer many attractions to the collector and student of superficial deposits. — FRED. W. SIMONDS, Cornell University.

GEOGRAPHY AND EXPLORATION.

EXPLORATIONS OF THE POLARIS EXPEDITION TO THE NORTH POLE. — The reports of the scientific results of the Polaris expedition have been delayed simply, we are sorry to say, for want of means for publication. Dr. Bessels, the scientist of the expedition, made valuable collections of animal life at Polaris Bay, between latitudes 81° 20' and 81° 50' N., and soon after his return placed in the writer's hands the insects and fresh-water crustacea. Now that the English expedition has returned it

¹ See *American Naturalist*, v. 314.